Discussion

Dr Francois Lacour-Gayet *(New York, NY)*. Primary repair of total abnormal pulmonary venous return using the sutureless technique is extremely appealing, and your experience in Toronto shows excellent results. The conventional repair results in terms of mortality and morbidity have significantly improved. We have found it best to use a technique that does not manipulate the pulmonary vein. Nevertheless, some anatomic forms remain at risk. They include, as you mentioned, the small pulmonary vein confluence in the infracardiac type, the mixed venous forms, and, for an unknown reason, the total vein associated with a single ventricle. I have a few questions.

In view of the good results you have observed, would you consider using the primary sutureless technique for miscellaneous and single ventricle forms, the total pulmonary resistance associated with heterotaxy-type single ventricle?

Dr Alghamdi. In our previously published report, sutureless repair was used as a primary procedure for PVS associated with TAPVD and isomeric atrial arrangement. Most of these patients had right atrial isomerism. Some patients also had a single ventricle. The results were encouraging. These patients were excluded from this cohort.

Dr Lacour-Gayet. One advantage of the technique is to be able to safely open the trunk of the pulmonary vein with minimal risk of stenosis. Do you always incise the pulmonary vein trunks using this technique?

Dr Alghamdi. The extension of the incision of the pulmonary venous confluence to the individual pulmonary veins will be applied if there is documented preoperative PVS or the pulmonary veins are small on the subjective intraoperative assessment. Therefore, extension of the incision to the individual veins is not done routinely.

Dr Lacour-Gayet. I have seen in your series that you report using the technique in the intracardiac form. The application of the technique to intracardiac form seems more challenging because by definition the pulmonary veins are attached to the heart by the width of the coronary sinus. Furthermore, the operation to unroof the coronary sinus and patch from the coronary sinus to the atrial septal defect is, in a way, already a sutureless technique. Would you comment on your experience in applying the sutureless technique to intracardiac types?

Dr Alghamdi. Performing the sutureless technique for the cardiac-type TAPVC is only performed when the unroofing of the coronary sinus is not adequate (ie, when there are documented small pulmonary veins).

Dr Lacour-Gayet. Finally, the occurrence of pulmonary vein obstruction after a repair seems unpredictable and could be in relation to an abnormal metabolism of the native pulmonary venous endothelium. In the situation in which a pulmonary venous obstruction occurs despite a perfect primary sutureless repair, you will be left with no ammunition to repair the pulmonary vein obstruction. Do you consider that this limitation could be a reason for elective primary sutureless repair only to the adverse form?

Dr Alghamdi. Can you repeat that again?

Dr Lacour-Gayet. While considering that once you have done the repair, you cannot do it again, the question is, if it happens despite an excellent surgery, won't you then be left with the only option of giving the patient to the cardiologist? And my question is, for the simple form, knowing that even with an excellent technique you sometimes can have pulmonary vein obstruction, it's not bad to have this ammunition ready.

Dr Alghamdi. PVS will develop in some patients, despite what is considered a "perfect" repair. We propose though, that the sutureless technique minimizes the "trigger" for the development of PVS. Although the sutureless technique does not abolish the risk of PVS, it is associated with a low incidence of PVS, which is a reasonable justification to use it up-front.

Dr Lacour-Gayet. I want to congratulate the group in Toronto for this innovative technique. It will be useful to elective patients.

Dr Peter Manning *(Cincinnati, Ohio)*. Just a quick technical question regarding bleeding complications. In a primary repair such as this, the planes behind the pericardium may not be as well socked in as in a child in whom PVS has developed after a prior operation. One experience that we have had using this technique in a child with infracardiac total veins as a primary procedure was bleeding, where the blood dissected from our newly created space down to the area where we had dissected and ligated the vertical vein. Do you avoid, particularly in the infracardiac cases, dissecting the vertical vein and just leave it patent? In the supracardiacs, do you still ligate the vein? How do you manage or avoid that problem?

Dr Alghamdi. Most of the infracardiac types have obstructed vertical veins anyway, so it would be reasonable to just leave the vertical vein alone. An alternative would be to ligate the vertical vein from the inside of the confluence to avoid dissecting around the vertical vein.

For the supracardiac type, it is not unreasonable to leave the vertical vein alone if it is obstructed. Our approach has been to ligate the vertical vein routinely.

In terms of the other bleeding complications, in a previous report, in those with post-repair stenosis, where the incision of the pulmonary vein extended toward the hilum of the lung, the integrity of the pleuro-pericardial junction was violated, which resulted in bleeding into the pleura space, and that was repaired by approximation of that area between the hilum and the pleura.

Dr Manning. I would imagine in these cases you're probably not opening the veins as far out toward the hilum as you would in a reoperative case as well.

Dr Alghamdi. That's absolutely correct.

Dr Renato Assad *(Sao Paulo, Brazil)*. In regard to an anticoagulation protocol, do you recommend any antithrombotic therapy for those patients undergoing a sutureless procedure for "simple" TAPVC?

Dr Alghamdi. One would think there is a raw surface in the left heart side that may initiate some thromboembolic complications. We do not have a standard protocol to anticoagulate these patients; it is based on the surgeon's discretion. Some surgeons would anticoagulate if they think the area of raw surface is extensive, and others would not. But certainly we haven't seen any thromboembolic complications associated with this primary repair even in the absence of anticoagulation.

Dr Assad. If you administer any antithrombotic therapy, how long would you suggest continuing treatment?

Dr Alghamdi. Nobody knows. But what we do sometimes, and that's again based on the surgeon's discretion, is continue treatment for 6 weeks.

Dr Assad. In regard to those patients who experienced progressive pulmonary venous obstruction after primary repair, have you given any endothelin-receptor antagonist or chemotherapy after sutureless repair?

Dr Alghamdi. No.

Dr Assad. Is there any protocol with chemotherapy or Persantine for those patients?

Dr Alghamdi. No, not at this time. Thank you!

Dr Zhou Hong *(Wuhan, China)*. I have one question. In our experience, I have had a case of TAPVC with a branch of the PVS. In your opinion, can the sutureless procedure be used in these patients?

Dr Alghamdi. If you had a TAPVC and the veins all drained into the confluence and one of these veins was really small, what we would do is open the confluence and extend the incision of the confluence into the vein itself until it appears healthy and then do the primary sutureless repair.

Dr James Tweddell *(Milwaukee, Wis)*. What if the stenosis extends outside the pericardia?

Dr Alghamdi. As long as that integrity between the pericardium and the pleura is intact, you can extend it toward the hilum of the lung. Extension of such an incision too far is not without potential risks. We have seen a similar patient (not part of this cohort) with mixed-type TAPVD and very small veins. The incision was extended into the hilum of the lungs. When the patient was transferred from the operating room to the intensive care unit, she required high-pressure ventilation because the lungs were very stiff. The patient immediately collapsed and required an ECMO. When the aortic cannula was inserted into the aorta, a significant amount of air was seen inside the aorta in the form of froth. That massive air embolism was possibly due to a communication with the left atrium. The patient was on ECMO for a few days and weaned successfully. She had a remarkable recovery with no significant complications and was discharged.